Factors Associated with Unplanned Reoperation in Perilunate Dislocations and Fracture Dislocations

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Abstract

Background Perilunate injuries are complex and uncommon injuries that are typically the result of a high-energy injury and are nearly always treated operatively. Little is known about factors associated with unplanned reoperations after surgery for perilunate injuries.

Purpose To assess the rate and types of unplanned reoperation after operative treatment of a perilunate dislocation.

Patients and Methods We reviewed 115 patients of all ages with unplanned reoperations after operative treatment of perilunate injuries at five hospitals. Planned removal of implants were not considered as unplanned reoperations.

Results Sixteen patients had an unplanned reoperation, including four for compartment syndrome (three hand, one forearm); three for deep infection; three for malalignment or an errant screw; two for early salvage procedures; and four for other reasons. We considered seven unplanned reoperations necessary (forearm compartment syndrome, infection, loss of alignment, errant screw) and nine debatable or unnecessary (hand compartment syndrome, early salvage procedures, suspected malunion, etc.). Patients who had an unplanned reoperation were younger (median age 24 versus 34 years; $p = 0.0034$); had earlier surgery (median days to surgery 0 versus 3; $p = 0.0068$); and were more likely injured in a motor vehicle collision (50% versus 17%; $p = 0.0070$). Accounting for interaction among the variables using multivariable analysis, the factors independently associated with unplanned reoperation were young age (odds ratio 0.92) and motor vehicle collision accidents (odds ratio 4.1).

Conclusion We conclude that higher-energy injuries may be at greater risk for unplanned reoperation, but more than half of the unplanned reoperations were for debatable indications.

Level III Retrospective Cohort Review

Keywords

- perilunate dislocations
- perilunate fracture dislocations
- reoperations
- risk factors

Perilunate dislocations (PLDs) and fracture-dislocations (PLFDs) typically result from high-energy injuries.[1,2] Surgery aims to fix fractures, align the carpal bones, repair the ligaments, and release pressure on the median nerve.[2–7] PLDs create wrist stiffness and midcarpal arthritis.[8–10]

Prior studies suggest that the most common reason for reoperation after transscaphoid PLFD is nonunion of the scaphoid.[11,12] Pin infection, deep infection, loss of fixation, loss of alignment, median neuropathy, and compartment syndrome are other reasons for unplanned reoperation.[10,13–15]

In this study we assess the rate and types of unplanned reoperation after operative treatment of a PLD. Our primary null-hypothesis was that there are no factors associated with unplanned reoperation among patients with PLDs or PLFDs.

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Patients and Methods

Study Design

This study was approved by our institutional review board, and a waiver of informed consent was obtained. We included 115 consecutive patients of all ages who had surgery for a perilunate dislocation of the wrist between 2003 and 2014 in a network of five area hospitals, the majority treated at the two level 1 trauma centers. Patients were identified using Current Procedure Terminology (CPT) codes: closed treatment of lunate dislocation, with manipulation (25690), open treatment of lunate dislocation (25695), and open treatment of transscaphoperilunar type of fracture-dislocation (25685). We excluded three cases with only closed reduction and/or no internal fixation. Planned removals of implants (e.g., buried pins or screws) were performed in 54 patients and were not considered as unplanned reoperations.

Outcome Measures

Our primary outcome measure was unplanned reoperation. Medical records were reviewed to determine whether patients had an unplanned second surgery.

Explanatory variables were: sex, age, smoking, comorbidity status, affected side, hand dominance, carpal tunnel release at initial surgery, open reduction and internal fixation of the scaphoid, temporary Kirschner wire (K-wire) fixation of the carpus, temporary screw fixation of the carpus, type of screw used to repair the scaphoid, use of suture anchors, planned second surgery for implant removal, open wound, polytrauma, median neuropathy, lunate dislocation, scaphoid fracture, capitate fracture, and fracture of other carpal bones.

Patient comorbidity status was assessed using the modified Charlson Comorbidity Index,[16,17] which provides a score ranging from 0 to 24, with a higher score representing more severe comorbidity status, based on 12 weighted comorbidities. We determined the modified Charlson Comorbidity Index through a previously described algorithm based on *International Classification of Diseases*, 9th revision (ICD9) codes given to the patient before the day of surgery.[18–20] Because these patients were generally young and healthy, comorbidity status was dichotomized into no comorbidities or any comorbidity for purposes of analysis.

Follow-up was defined as the last date a patient encountered one of the included institutions.

Polytrauma was defined as perilunate (fracture-)dislocation along with any other trauma (e.g., distal radius fracture, chest injury, head injury).

The remaining explanatory variables were extracted from medical records.

Trauma mechanism was subdivided in motor vehicle collision (MVC) or no MVC. Two different types of headless screws were used to repair the scaphoid: fully threaded and Herbert-type.

Statistical Analysis

Bivariate analysis was used to assess the association between explanatory variables and reoperation by Fisher's exact test for categorical variables and Mann-Whitney *U* test (also known as the Wilcoxon rank-sum test) for continuous variables. We used nonparametric analysis for continuous variables, as visual inspection of histograms suggested non-normal distributions.

Stepwise forward multivariable logistic regression analysis was used to assess the independent relationship of explanatory variables with reoperation by including all variables with a p value below 0.05 in bivariate analysis. All statistical analyses were performed using Stata® 13 (StataCorp LP, College Station, TX, USA) and a two-tailed p value below 0.05 was considered significant.

Patient Characteristics

One hundred and fifteen patients who underwent surgery for a primary PLD were included, 16 of whom (14%) had an unplanned reoperation. There were 99 men (86%) and 16 women (14%) with a median age at time of surgery of 31 years (range 23–42). For 25 patients (22%), the injury was caused by MVC, and in 56 patients (49%) the right hand was affected. The median follow-up time was 12 months (range 3–53) (►**Table 1**).

Results

In bivariate analysis, we found that younger age ($p = 0.0034$), shorter time between injury and primary surgery ($p = 0.0068$), and MVC trauma mechanism ($p = 0.0070$), were associated with unplanned reoperation (►**Table 2**). We compared reoperation rates among the fully threaded screw (27% [15 of 56 cases]) and Herbert-type screw (73% [41 of 56 cases]) in a subanalysis and found no association with unplanned reoperation ($p = 0.052$).

Multivariable logistic regression analysis demonstrated that younger age (odds ratio 0.92, standard error 0.035, 95% confidence interval: 0.85–0.99, $p = 0.022$) and MVC trauma mechanism (odds ratio 4.1, standard error 2.4, 95% confidence interval: 1.3–13, $p = 0.018$) were independently associated with an increased risk of unplanned reoperation. The odds of reoperation decrease with 9% per one-unit increase in age, and the odds of reoperation are 4.5 times higher in the MVC group as compared with the non-MVC group (►**Table 3**).

Table 1 Baseline characteristics of included patients

	Median (interquartile range)
Age (years)	31 (23–42)
Follow-up (days)	362 (94–1,576)
	n (%)
Modified Charlson Comorbidity index > 0	7 (6)
Smoking	18 (20)
Male	99 (86)
Right hand affected	56 (49)
Right hand dominance	62 (91)

Table 2 Bivariate analysis of factors associated with reoperation

	Perilunate dislocation reoperation ($n = 16$)	Perilunate dislocation primary surgery ($n = 99$)	
	Median (interquartile range)	Median (interquartile range)	*p* Value
Age (years)	24 (20–29)	34 (25–45)	**0.0034**
Time to surgery (days)*	0 (1–3)	3 (0–8)	**0.0068**
	n (%)	n (%)	
Male	13 (81)	86 (87)	0.70
Modified Charlson Comorbidity index > 0	2 (13)	5 (5)	0.25
Smoking*	2 (17)	16 (20)	0.99
Trauma mechanism: motor vehicle collision	8 (50)	17 (17)	**0.0070**
Right hand affected	8 (50)	48 (48)	0.99
Right hand dominance*	8 (100)	54 (90)	0.99
Carpal tunnel release	13 (81)	65 (66)	0.26
Scaphoid ORIF	15 (94)	94 (95)	0.99
Temporary K-wire	12 (75)	84 (85)	0.30
Temporary screw	11 (69)	59 (60)	0.59
Anchor	10 (63)	56 (57)	0.79
Removal hardware	8 (50)	46 (47)	0.80
Open wound	1 (6)	4 (4)	0.53
Multitrauma	7 (44)	21 (21)	0.064
Median nerve injury	9 (56)	31 (31)	0.087
Lunate dislocation	1 (6)	25 (25)	0.12
Carpal fracture	12 (75)	61 (62)	0.41
Fracture scaphoid	11 (69)	49 (50)	0.18
Fracture capitate	2 (13)	6 (6)	0.31
Fracture other carpals	5 (31)	20 (20)	0.34

Bold indicates significant (*p* value below 0.05).
* Variable total number of patients differs from total *n*: total patients with primary surgery (total number of patients with reoperation): Time to surgery 94,[16] Smoking 79,[12] and Dominance 60.[8]

The most common reasons for reoperation in our cohort were compartment syndrome (3.5% [4 of 115 cases, 3 diagnosed in the hand]), malunion/nonunion (2.6% [3 of 115 cases]), and deep infection (2.6% [3 of 115 cases]) (►**Table 4**).

Discussion

Perilunate (fracture-)dislocations are complex injuries that may cause impairment due to stiffness and the development of carpal malalignment, leading to arthritis of the radiocarpal

Table 3 Forward stepwise multivariable logistic regression analysis of factors associated with reoperation

	Odds ratio	Standard error	*p* value	95% confidence interval	
Trauma mechanism: MVC	4.1	2.4	0.018	1.3	13
Age	0.92	0.035	0.022	0.85	0.99

Trauma mechanism, age, and time to surgery were included in the forward stepwise multivariable logistic regression.

Table 4 Patient characteristics with unplanned reoperation

#	Complication	Sex	Age (years)	Trauma mechanism: motor vehicle collision	Time to reoperation (days)	Procedure
1, 2, 3	Compartment syndrome, hand	Male, Male, Male	29, 20, 49	Yes, no, yes	1, 1, 2	Fasciotomy hand
4	Compartment syndrome, forearm	Female	22	Yes	1	Fasciotomy forearm
5	Deep infection	Female	20	Yes	14	I&D*, HR**, and external fixation
6	Suspected malunion scaphoid	Male	16	No	56	Exploration scaphoid
7	Deep infection	Male	23	No	63	I&D
8	Deep infection	Male	25	Yes	94	I&D
9	Spontaneous recurrence perilunate dislocation	Male	37	No	100	Pinning, SL-ligament reconstruction
10	Malunion scaphoid	Male	25	Yes	111	Excision scaphoid, ORIF*** bone graft
11	Widening of the scapholunate gap	Female	32	No	131	SL-ligament reconstruction
12	Malpositioned screw	Male	19	No	150	RH, ORIF scaphoid, repair SL-ligament,
13	Nonunion scaphoid	Male	20	No	210	ORIF scaphoid
14	Stiffness/tendon adhesions	Male	27	No	222	Tendolysis
15	Migrated suture causing swelling	Male	28	Yes	362	Removal suture
16	Nonunion scaphoid	Male	23	Yes	548	Carpectomy scaphoid, fusion carpals

* Irrigation and débridement.
**Hardware removal.
*** Open reduction internal fixation.

and midcarpal joints.[8–10] In this study we looked for factors associated with unplanned reoperation. We found that younger age and MVC trauma mechanism were associated with unplanned reoperation after surgery for perilunate dislocations.

This study has some limitations. First, the retrospective nature of the study did not allow us to include all potential risk factors for reoperation, such as more specific injury classification, technical difficulties encountered during surgery, and preoperative wrist function and morbidities. Second, patients might have received an unplanned reoperation at a different institution. We see this as a minor limitation, as we included many of the centers in our region and the time of final evaluation averaged 1 year (range from 3 months to 4 years). Third, the relatively low number of unplanned reoperations ($n = 16$) limited the number of variables we could include in the multivariable logistic regression. Therefore, it was not possible to account for all potential confounders. However, based on our strategy of choosing variables based on the bivariate analysis, we expect that the most important explanatory variables were included. A larger sample with more reoperations might have resulted in more statistical power to detect subtle but relevant risk factors.

The finding that youth and involvement in an MVC are independent risk factors for unplanned reoperation after perilunate injury suggests that the highest-energy injuries may be at particular risk. Prior studies identified nonunion of the scaphoid as the primary reason for reoperation.[11,12] It seems that, with current techniques and implants, scaphoid nonunion meriting additional surgery is uncommon. Among the factors associated with poor outcome in prior studies of PLDs (e.g., open injury, delayed treatment, osteochondral fracture of the capitate, and presence of persistent carpal malaligment),[1,21,22] only persistent carpal malalignment was associated with unplanned reoperation in the early recovery period.

In our opinion seven of the unplanned reoperations were necessary (forearm compartment syndrome, infection, loss of alignment, errant screw), and nine were debatable or unnecessary (hand compartment syndrome, early salvage procedures, suspected malunion, etc.). The rate of unplanned reoperation might therefore be as low as 7 of 115 (6%) or as high as 16 of 115 (14%) among a large number of surgeons at several hospitals—a number that is likely to apply to other surgeons in other settings. The common reasons for unplanned reoperations in prior studies were similar to those in our study: pin track infection, wound infection, skin irritation, implant failure, flexor tendon adhesions, loss of reduction, scaphoid nonunion or malunion, and painful implants.[10,13–15]

Among the unplanned reoperations that were potentially unnecessary, the diagnosis of three hand compartment syndromes was seemingly based on concern about substantial swelling in the hand. Given that substantial hand swelling is quite common after perilunate injuries, it seems safe to assume that many patients had a similar exam and were not diagnosed with compartment syndrome. Reading the medical record, one gets the impression that a protective response to pain might have made the surgeons nervous, leading to diagnosis of hand compartment syndrome. Contrast this with the one release of a forearm compartment syndrome, where there was progressive disproportionate pain, pain with passive stretch, and the development of numbness. Because hand compartment syndrome does not cause objective changes such as nerve dysfunction, the diagnosis and treatment are more debatable. Likewise, the surgeries for suture reaction and suspected malunion were probably unnecessary, and the early salvage procedures seem a bit questionable. It is important to highlight these more debatable operations to emphasize that unplanned reoperation or revision surgery is not an entirely objective measure of the success of the initial treatment.

In conclusion, higher-energy injuries seem to be at greater risk for unplanned reoperation, but more than half of the unplanned reoperations were for debatable indications. In our opinion, perilunate injuries receive generally effective treatment in our area, and the search for modifiable risk factors for unplanned reoperation might focus primarily on the risk of infection, most of which seem to start as pin track infections.

Conflict of Interest
None

References

1 Herzberg G. Acute dorsal trans-scaphoid perilunate dislocations: Open reduction and internal fixation. Tech Hand Up Extrem Surg 2000;4(1):2–13
2 Budoff JE. Treatment of acute lunate and perilunate dislocations. J Hand Surg Am 2008;33(8):1424–1432
3 Apergis E, Maris J, Theodoratos G, Pavlakis D, Antoniou N. Perilunate dislocations and fracture-dislocations. Closed and early open reduction compared in 28 cases. Acta Orthop Scand Suppl 1997;275:55–59
4 Melone CP Jr, Murphy MS, Raskin KB. Perilunate injuries. Repair by dual dorsal and volar approaches. Hand Clin 2000;16(3):439–448
5 Weil WM, Slade JF III, Trumble TE. Open and arthroscopic treatment of perilunate injuries. Clin Orthop Relat Res 2006;445(445):120–132
6 Adkison JW, Chapman MW. Treatment of acute lunate and perilunate dislocations. Clin Orthop Relat Res 1982;(164): 199–207
7 Sauder DJ, Athwal GS, Faber KJ, Roth JH. Perilunate injuries. Orthop Clin North Am 2007;38(2):279–288, vii
8 Herzberg G, Comtet JJ, Linscheid RL, Amadio PC, Cooney WP, Stalder J. Perilunate dislocations and fracture-dislocations: a multicenter study. J Hand Surg Am 1993;18(5):768–779
9 Grabow RJ, Catalano L III. Carpal dislocations. Hand Clin 2006; 22(4):485–500, abstract vi–vii
10 Hildebrand KA, Ross DC, Patterson SD, Roth JH, MacDermid JC, King GJ. Dorsal perilunate dislocations and fracture-dislocations: questionnaire, clinical, and radiographic evaluation. J Hand Surg Am 2000;25(6):1069–1079
11 Divecha HM, Clarke JV, Barnes SJ. Established non-union of an operatively managed trans-scaphoid perilunate fracture dislocation progressing to spontaneous union. J Orthop Traumatol 2011; 12(3):159–162
12 Ablove RH, Abrams SS. The use of BMP-2 and screw exchange in the treatment of scaphoid fracture non-union. Hand Surg 2015; 20(1):167–171
13 Trumble T, Verheyden J. Treatment of isolated perilunate and lunate dislocations with combined dorsal and volar approach and intraosseous cerclage wire. J Hand Surg Am 2004;29(3): 412–417
14 Knoll VD, Allan C, Trumble TE. Trans-scaphoid perilunate fracture dislocations: results of screw fixation of the scaphoid and lunotriquetral repair with a dorsal approach. J Hand Surg Am 2005; 30(6):1145–1152
15 Souer JS, Rutgers M, Andermahr J, Jupiter JB, Ring D. Perilunate fracture-dislocations of the wrist: comparison of temporary screw versus K-wire fixation. J Hand Surg Am 2007;32(3): 318–325
16 Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40(5):373–383
17 Quan H, Li B, Couris CM, et al. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. Am J Epidemiol 2011;173(6):676–682
18 Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992;45(6):613–619
19 Quan H, Parsons GA, Ghali WA. Validity of information on comorbidity derived from ICD-9-CCM administrative data. Med Care 2002;40(8):675–685
20 Voskuijl T, Hageman M, Ring D. Higher Charlson Comorbidity Index Scores are associated with readmission after orthopaedic surgery. Clin Orthop Relat Res 2014;472(5):1638–1644
21 Trumble T. Fractures and dislocations of the carpus. In: Trumble T, ed. Principles of Hand Surgery and Therapy. Philadelphia, PA: WB Saunders; 2000:90–125
22 Herzberg G, Forissier D. Acute dorsal trans-scaphoid perilunate fracture-dislocations: medium-term results. J Hand Surg [Br] 2002;27(6):498–502